Ecological Niche Factor Analysis

Modelling species Habitat Suitability with presence only data

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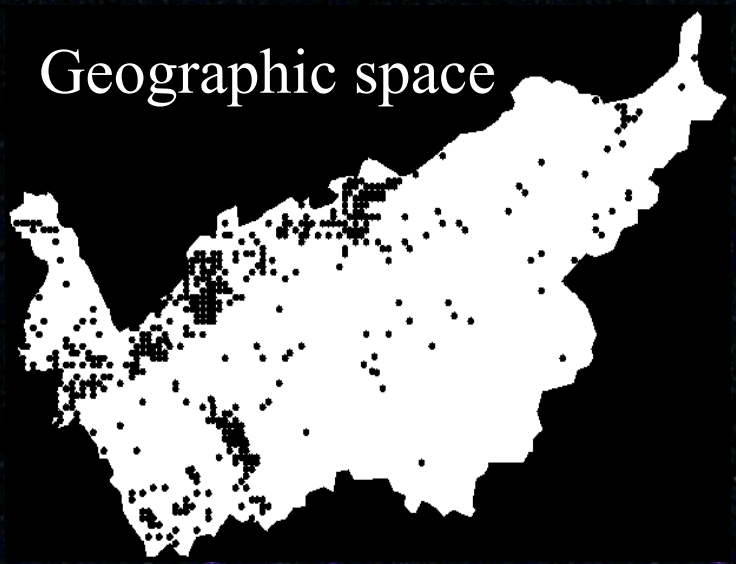
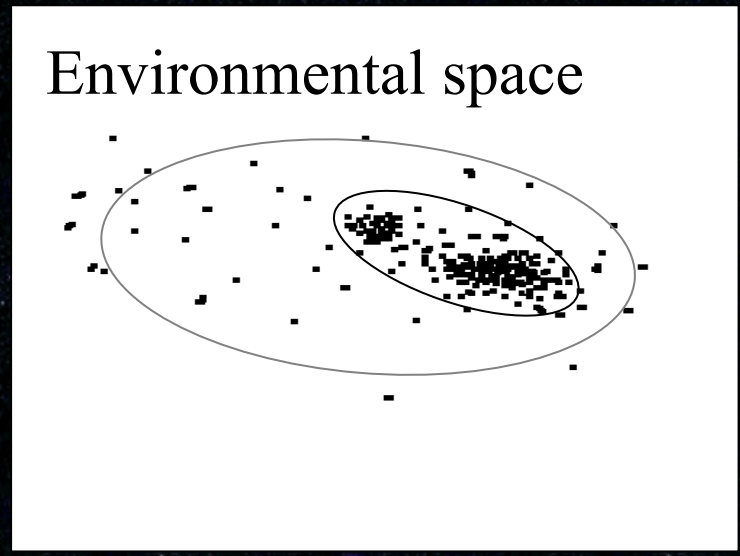
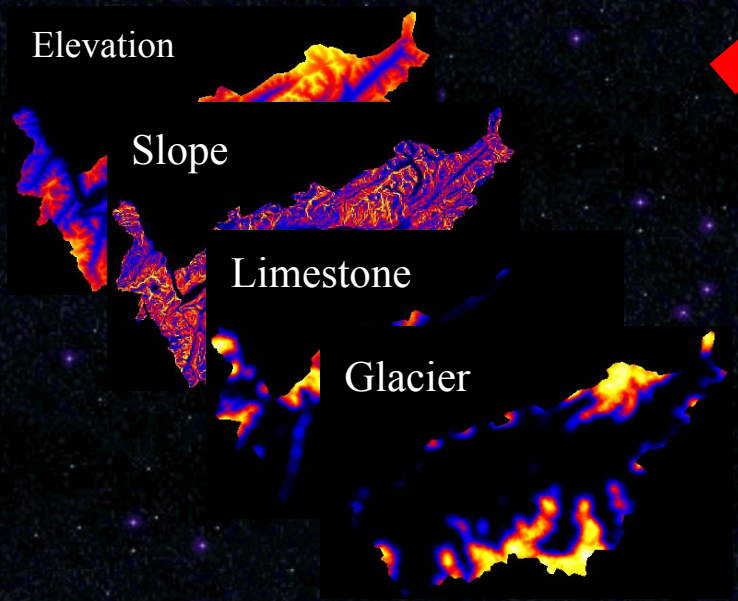
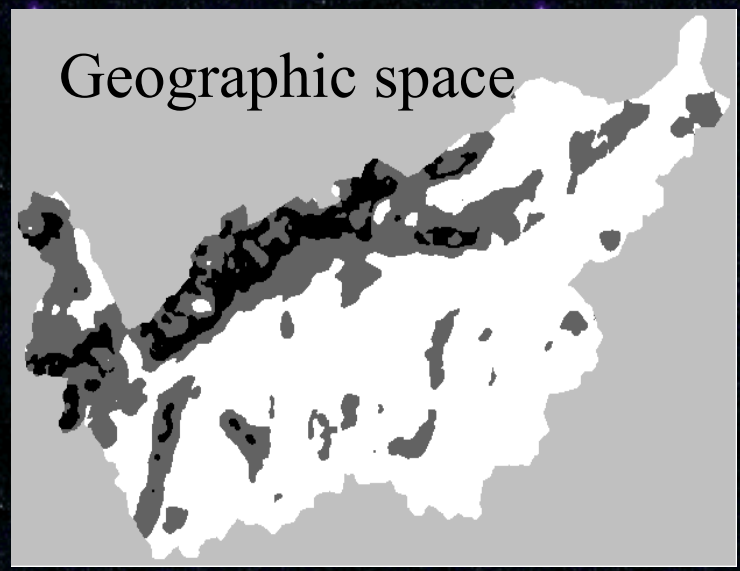
Introduction

Habitat suitability modelling



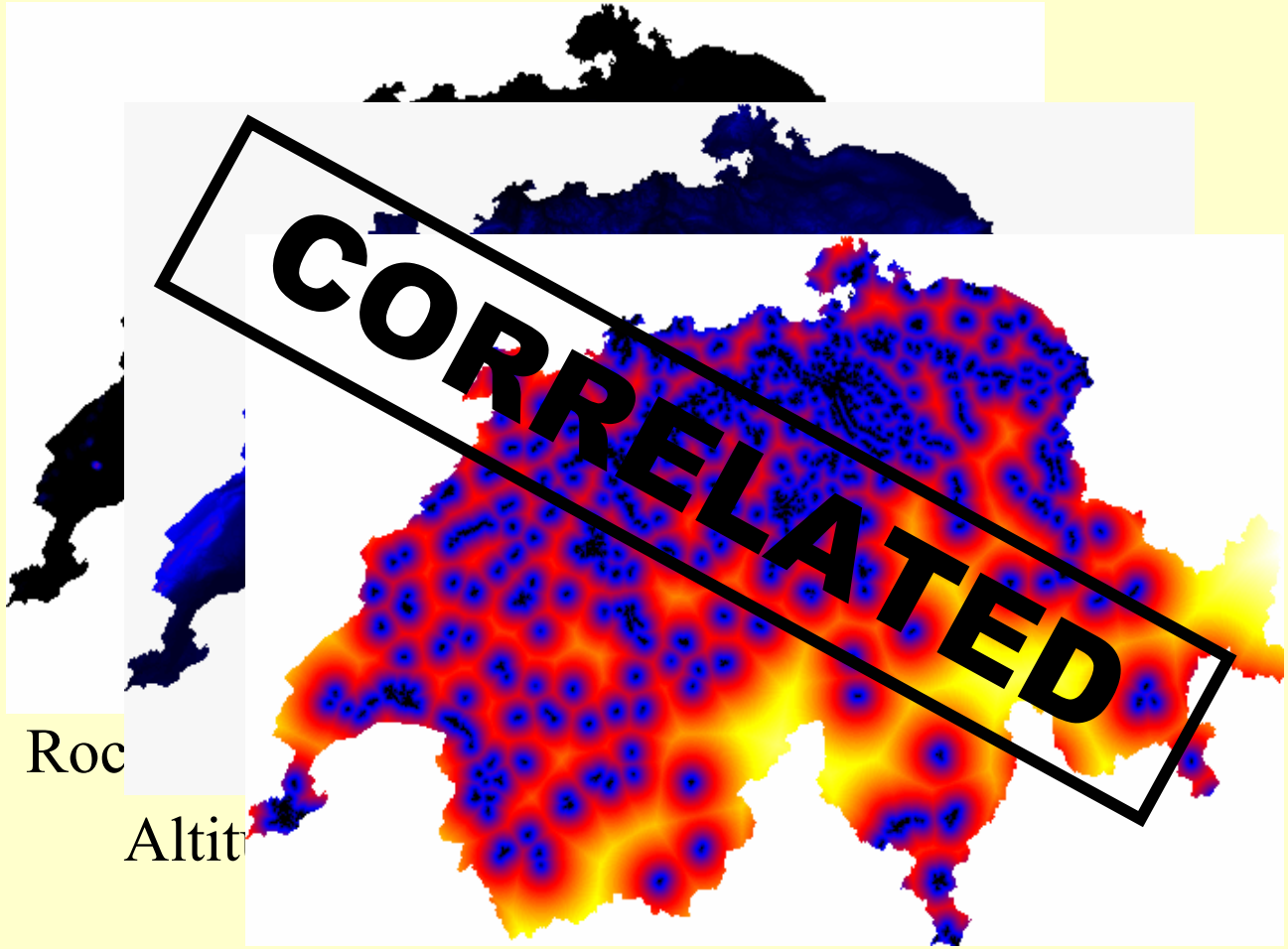






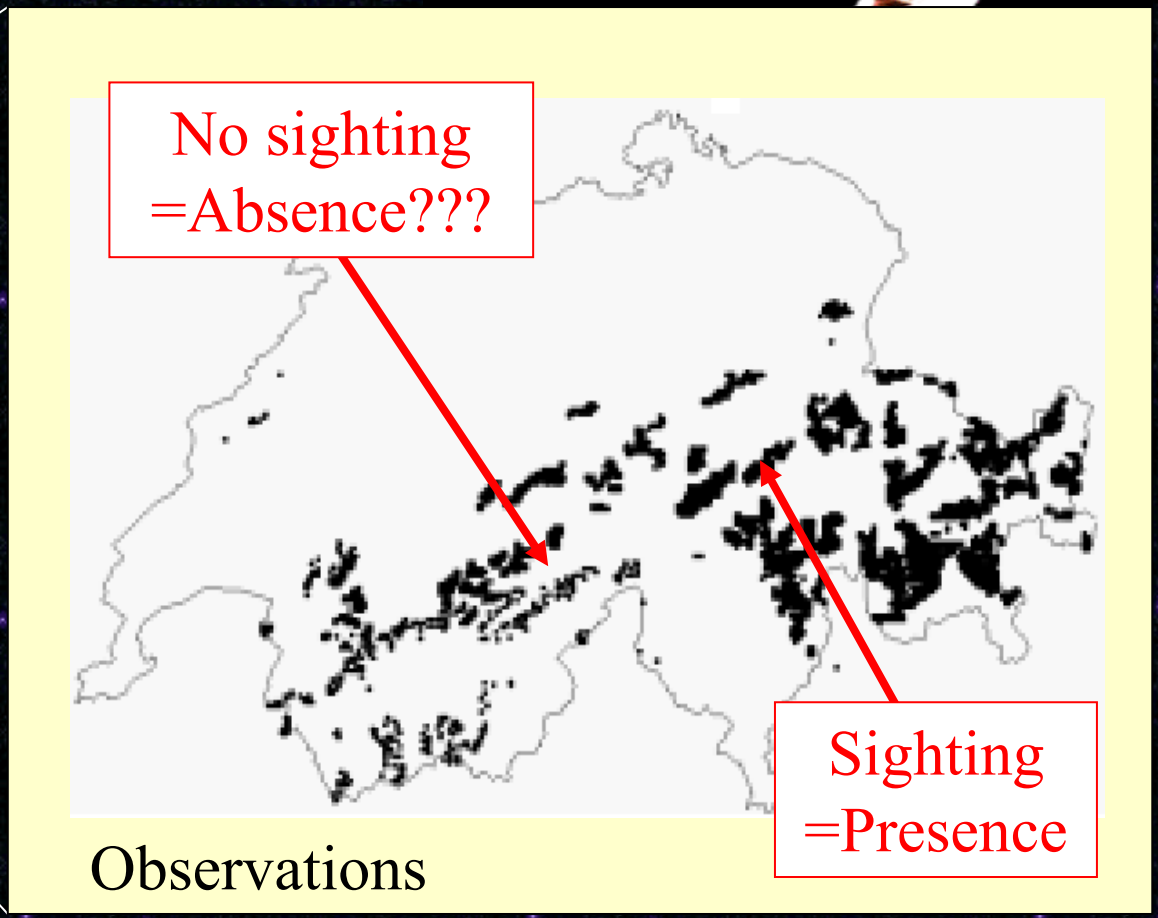
Habitat Suitability: input

- Input
  - Ecogeog
  - Observa



Habitat Suitability: input

- Input
  - Ecogeographical
  - Observation map



Absences

An “absence” (=no observation) may be due to:

- Species undetected ⇒ FALSE ABSENCE
- Dispersal barriers ⇒ FALSE ABSENCE
- Local temporary extinction ⇒ FALSE ABSENCE
- Too small territory ⇒ FALSE ABSENCE
- Unsuitable habitat ⇒ TRUE ABSENCE

Habitat Suitability: input

- Input
  - Ecogeographical
  - Observation map

Observations

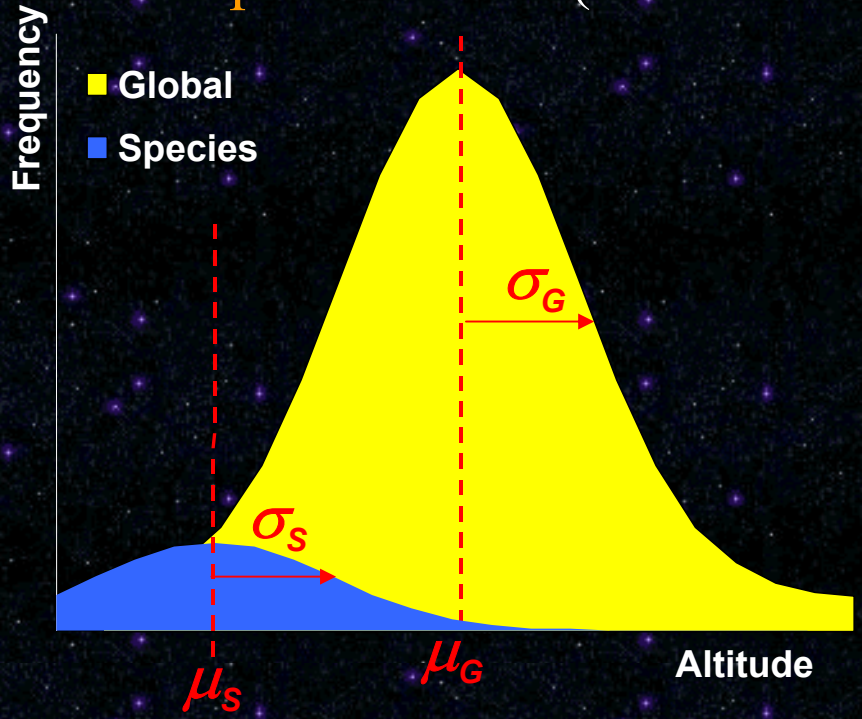
Ecological Niche Factor Analysis

Ecological Niche Factor Analysis

- Principles:
  - Summarises all variables into a few uncorrelated factors.
  - Takes only presence data into account.
  - Compares the species distribution to the global (available) environment.
  - Built on the concepts of marginality and specialisation.

Marginality & Specialisation

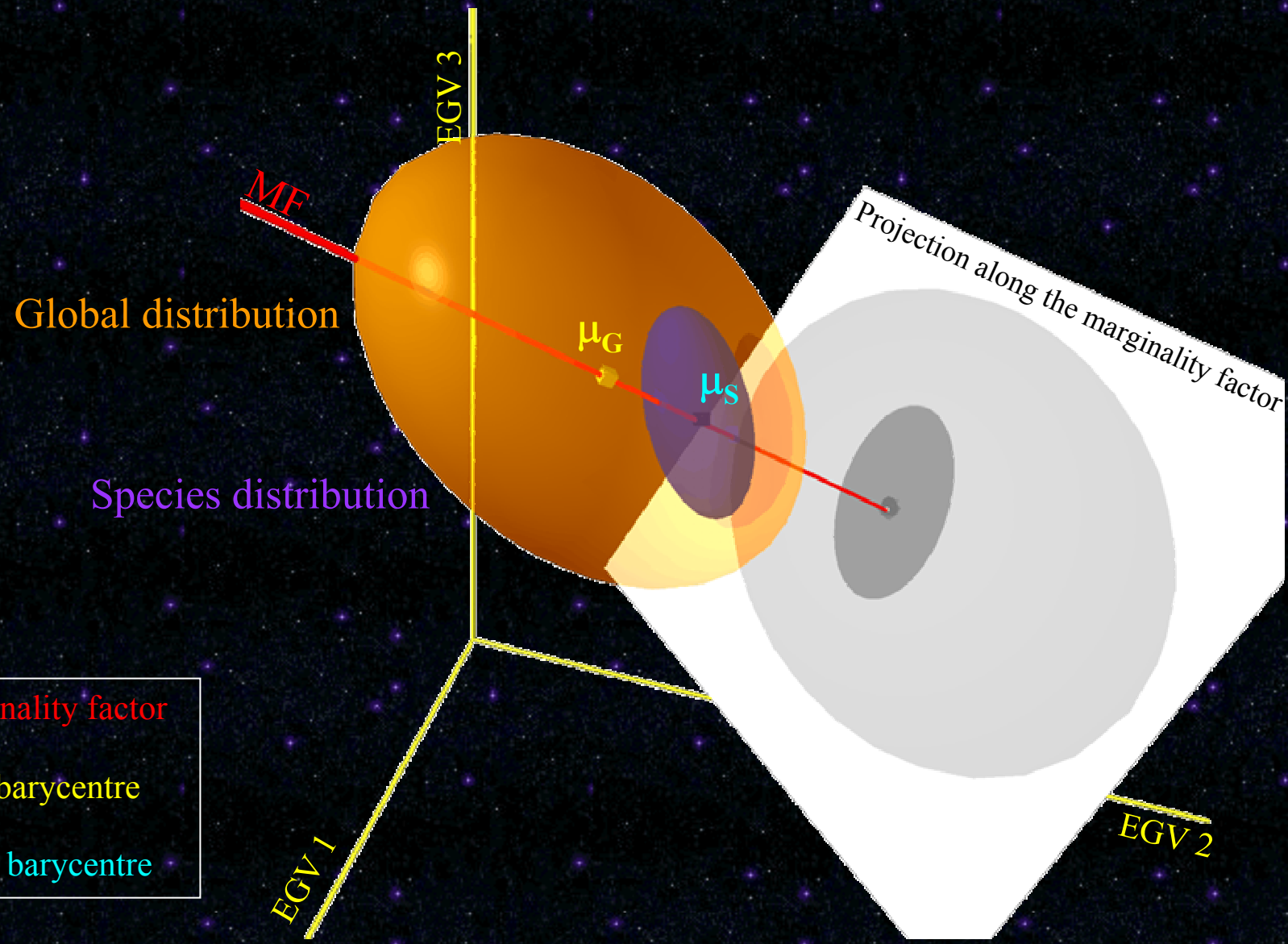
- Species niche is a subset of the global environment.
- Species set of EGV differs from global set by:
  - Marginality (deviation from the global mean)
  - Specialisation (niche breadth)



$$\text{Marginality} = \frac{|\mu_G - \mu_S|}{1.96\sigma_G}$$

$$\text{Specialisation} = \frac{\sigma_G}{\sigma_S}$$

Factor computation: Marginality

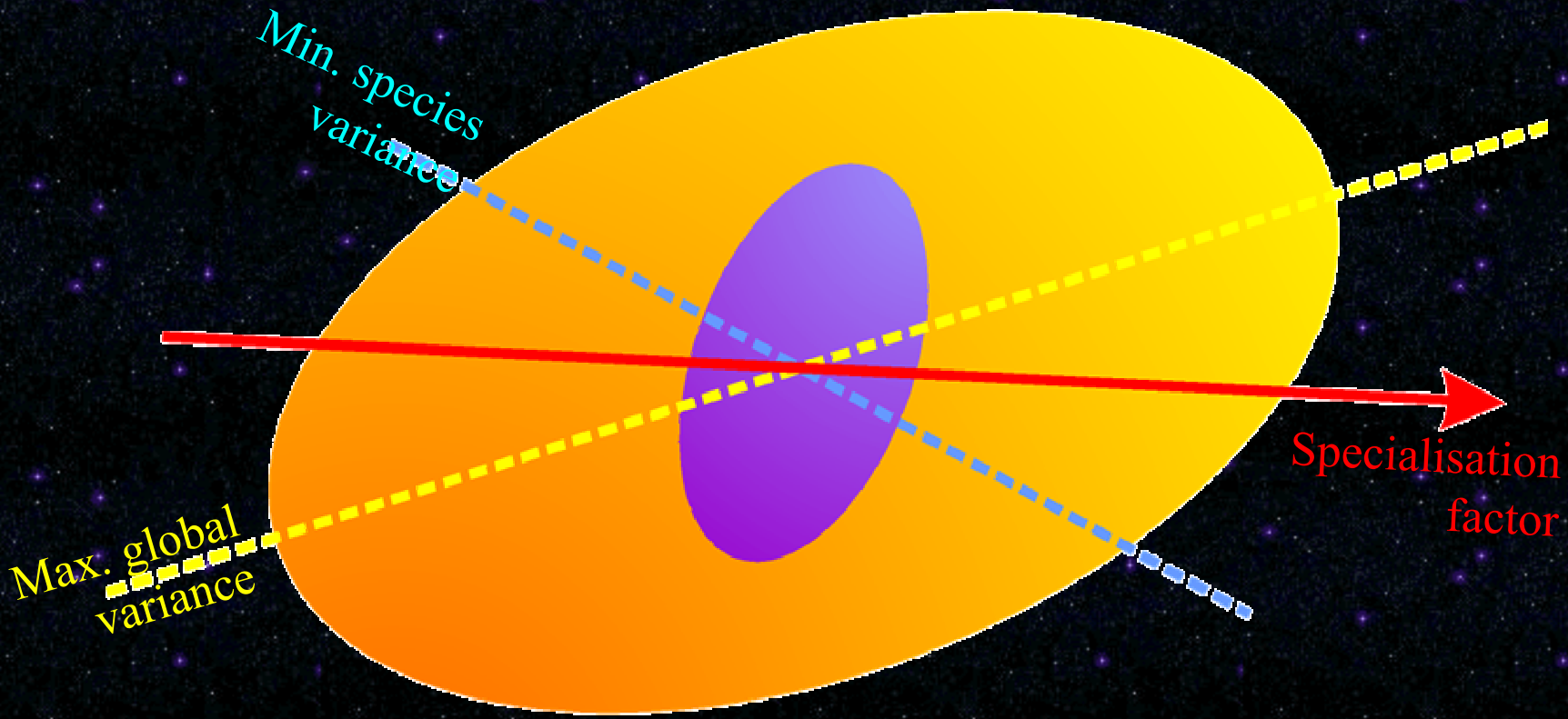


MF = Marginality factor

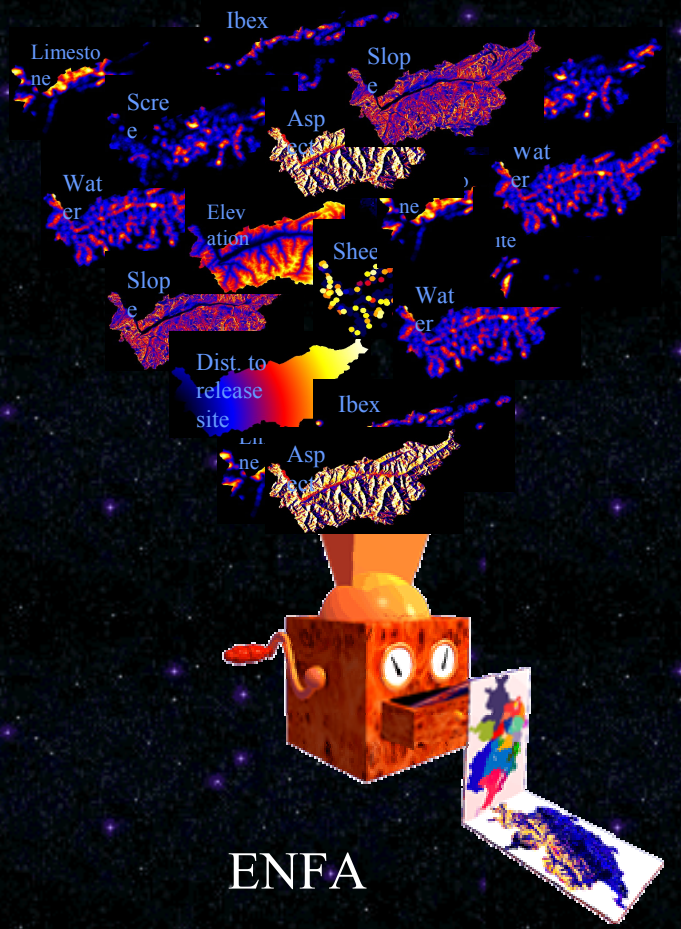
μ_G = global barycentre

μ_S = species barycentre

Factor computation: Specialisation

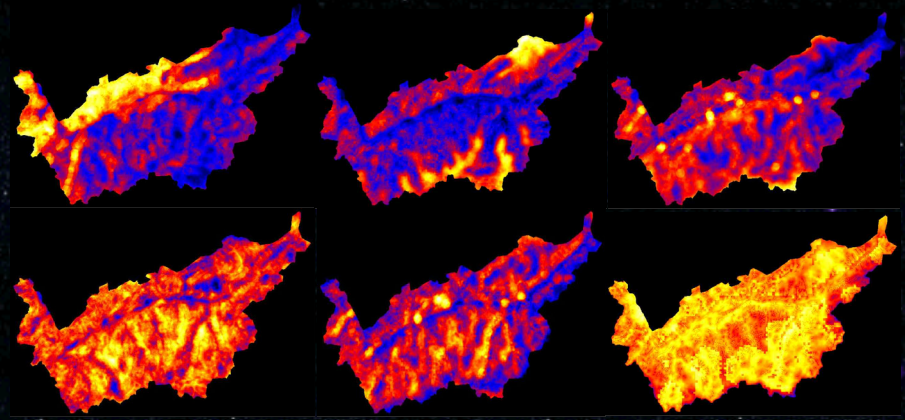


From geographic space to environmental space



24 predictors

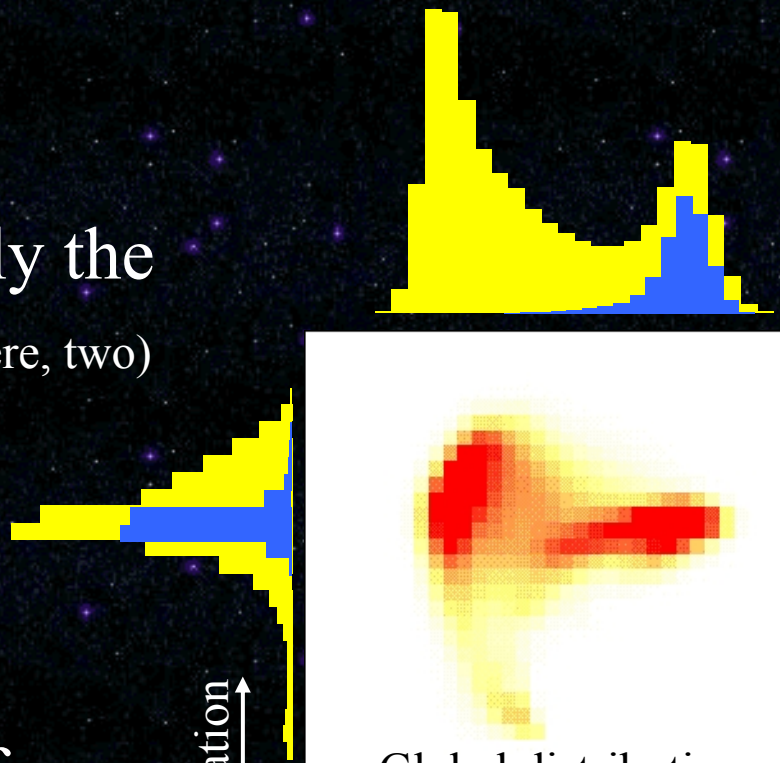
6 factors = 80% of information



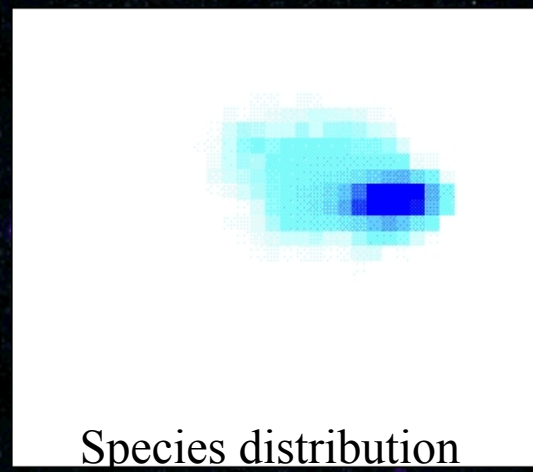
Habitat suitability

Habitat suitability computation

- Let's keep only the first factors (here, two)



Global distribution

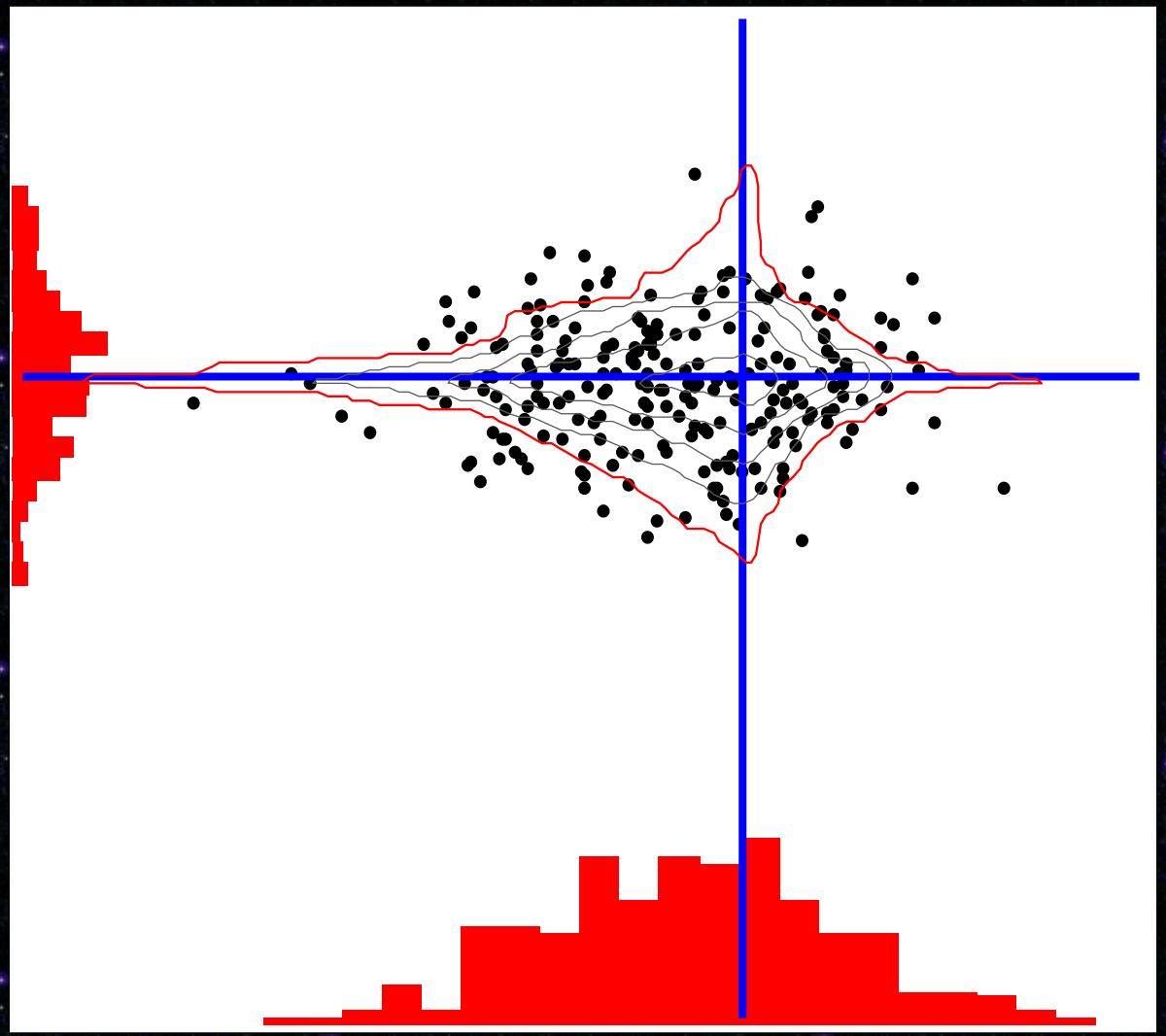

Species distribution

- We compute for each cell its probability to be in the species distribution

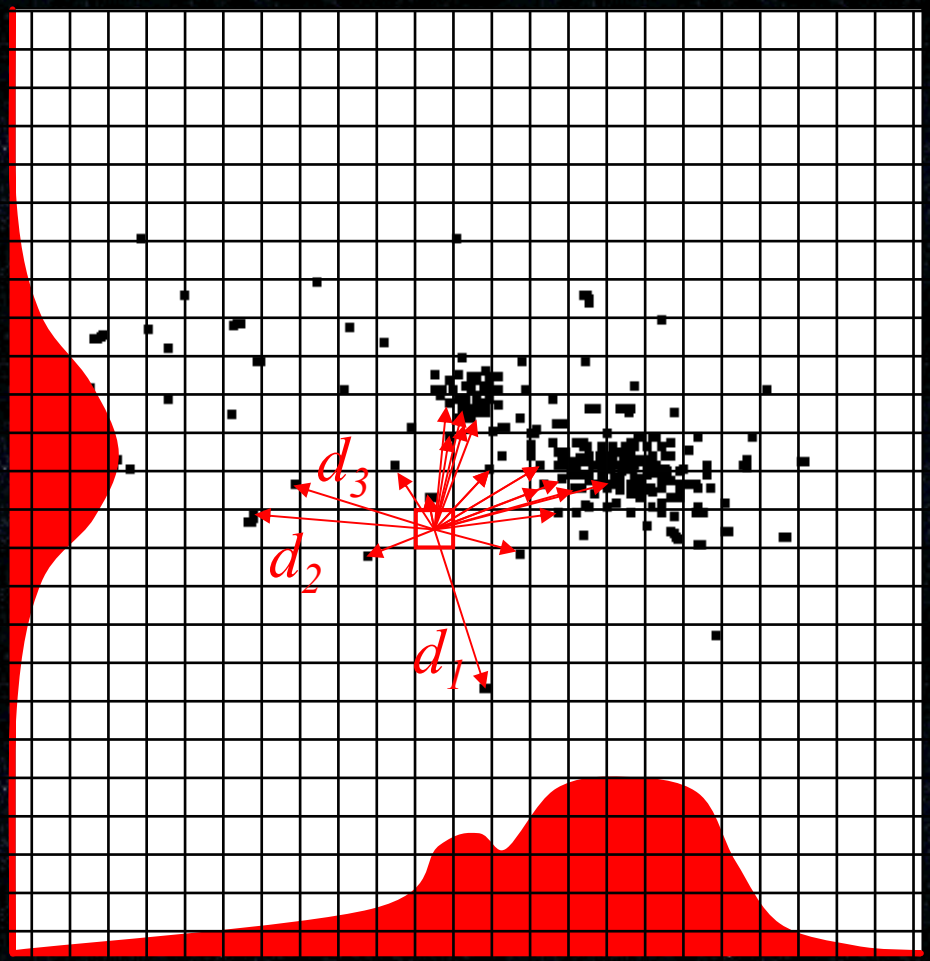
Median envelopes

- BIOMAPPER 1.0 (Hausser 1995, Hirzel *et al.* 2002)

- Envelope defined by the frequency distribution and the median.
- Assumes an unimodal and symmetrical distribution.



Distance geometric mean

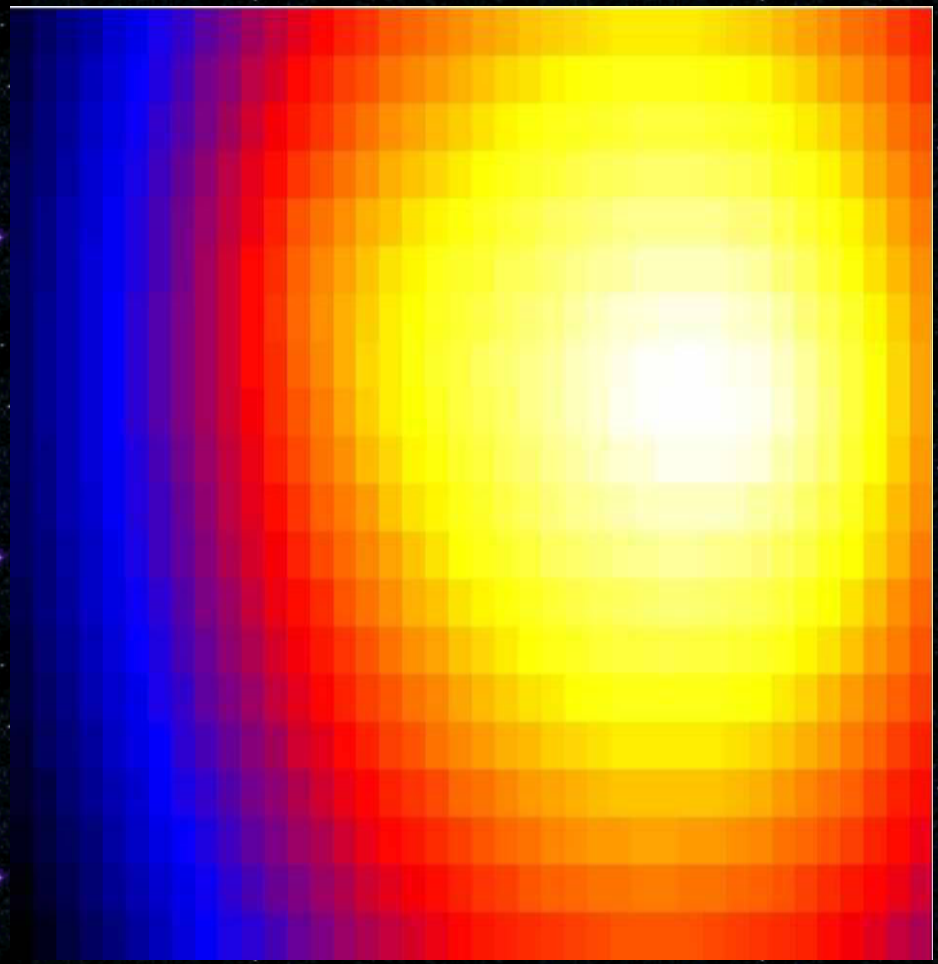


Compute the geometric mean of the distances:

$$H_G = \sqrt[N]{\prod_{i=1}^{N} d_i}$$

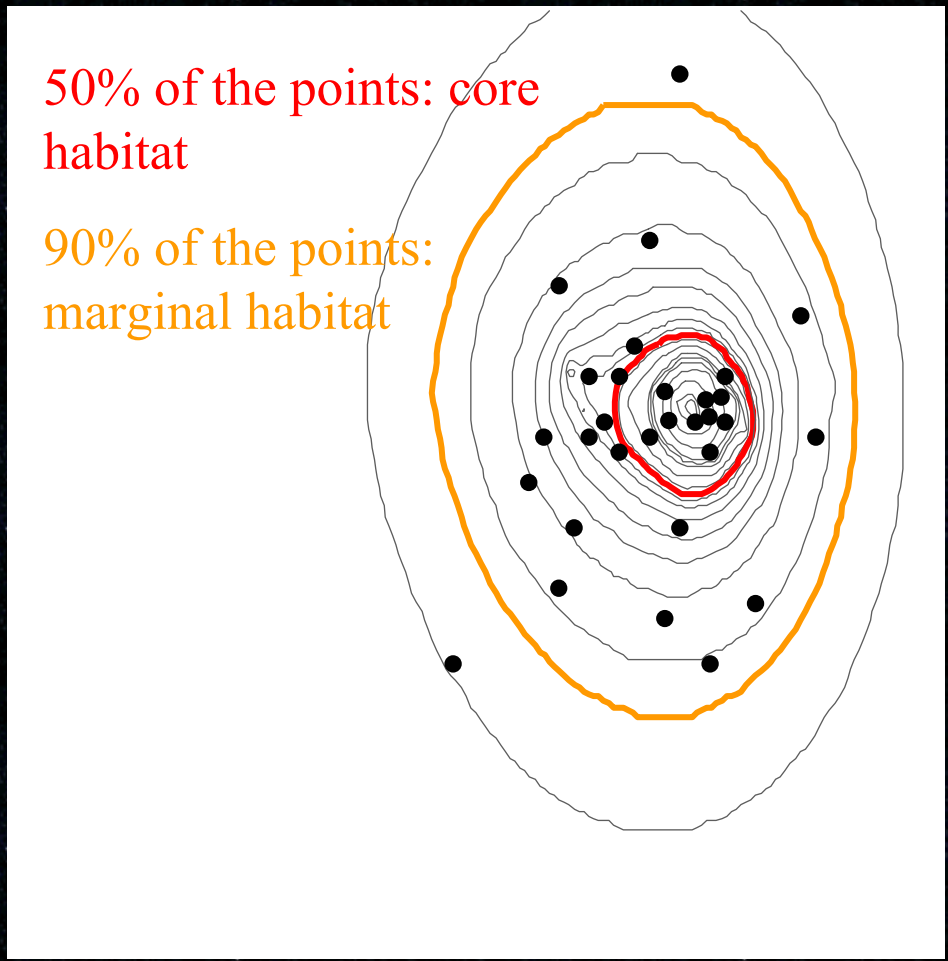
BIOMAPPER 3.0 (Hirzel & Arlettaz 2003, Hirzel *et al.* 2004)

Distance geometric mean



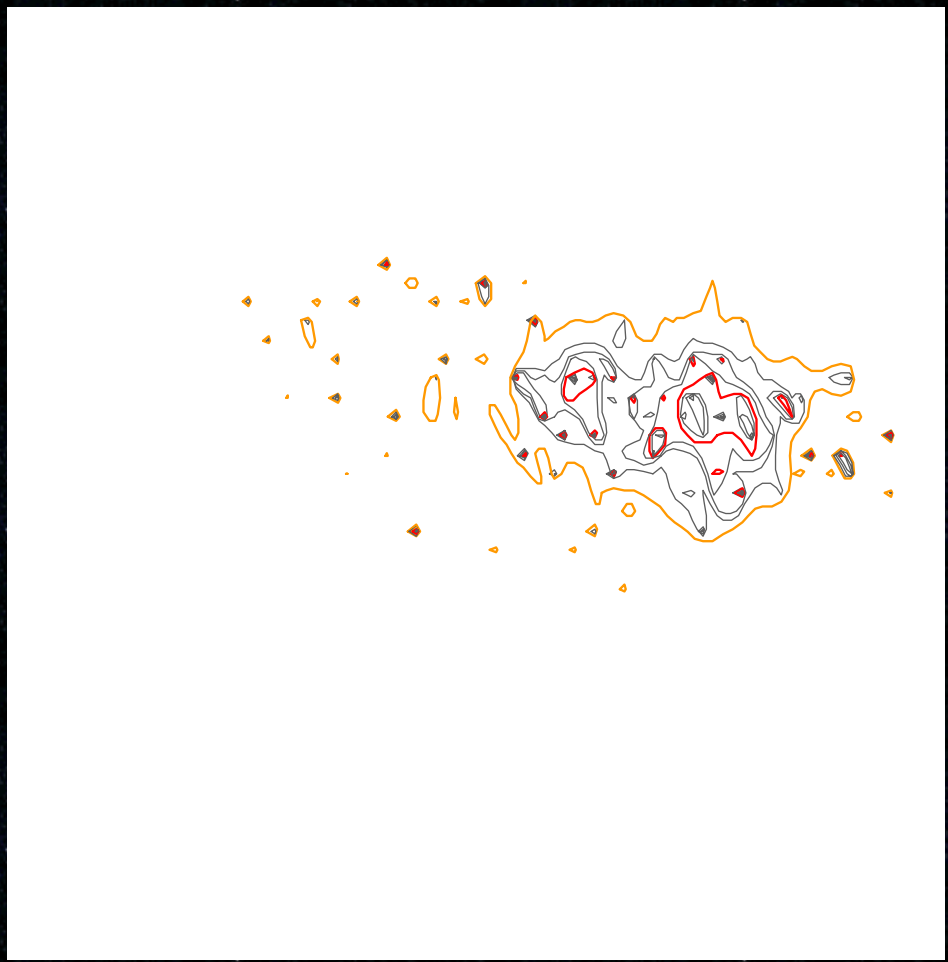
Do that for the whole environmental space, computing a habitat suitability field

Distance geometric mean



Envelopes are based on this field and the observation points.

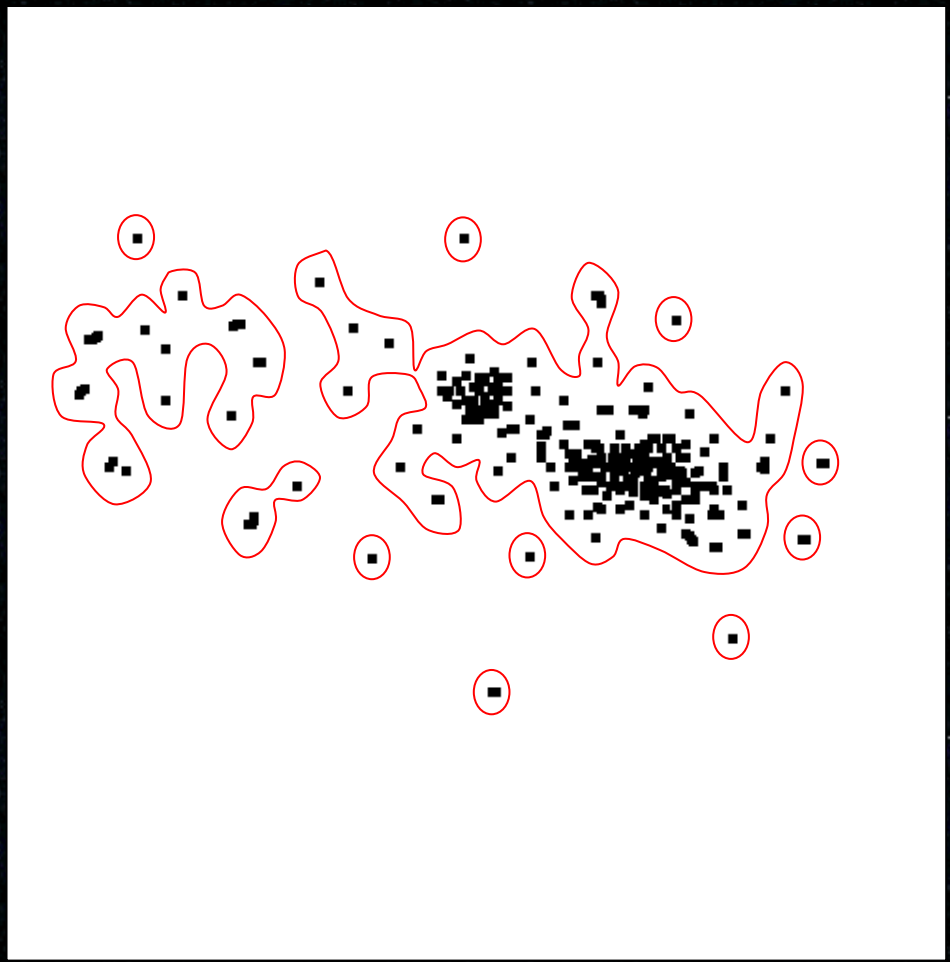
Distance harmonic mean



Similar to the geometric mean, but based on the harmonic mean of the distances:

$$H_H(\mathbf{P}) = \frac{1}{\frac{1}{N}\sum_{i=1}^{N}\frac{1}{\delta(\mathbf{P},\mathbf{O}_i)}}$$

Minimum distance

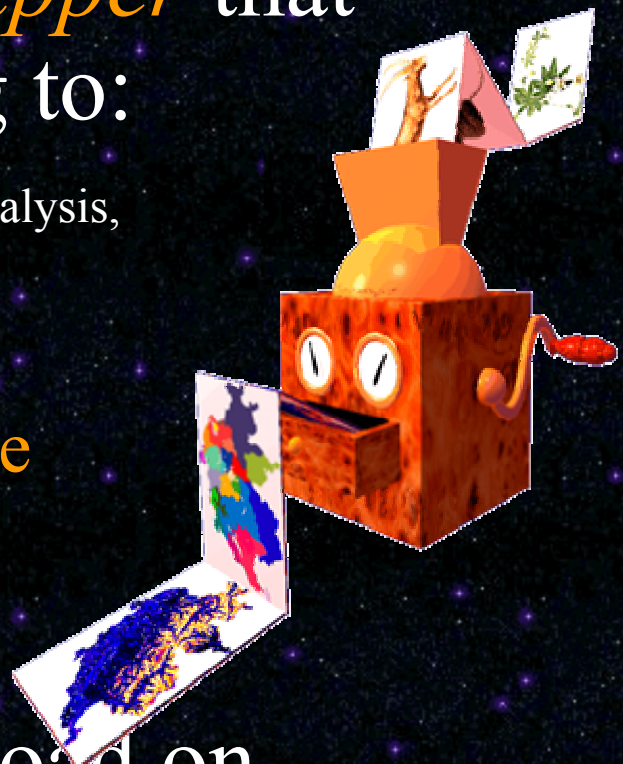


Or just keep the distance to the closest point:

$$H_{\min}(\mathbf{P}) = \mathrm{Min}\{\delta(\mathbf{P}, \mathbf{O}_i)\}$$

Biomapper

- This method has been implemented into a software named *Biomapper* that pools eco-GIS tools allowing to:
  - Prepare the variable maps (circular analysis, normalisation, etc.)
  - Explore them (visually and statistically)
  - Model the species ecological niche
  - Build Habitat Suitability maps
  - Evaluate them
- More information and download on http://www.unil.ch/biomapper



Related papers and co-authors

- Hirzel, A.H., Hausser, J., Chessel, D., and Perrin, N. (2002) Ecological-niche factor analysis: How to compute habitat- suitability maps without absence data? *Ecology*, **83**, 2027-2036.

- Hirzel, A.H., and R. Arlettaz. 2003. Modelling habitat suitability for complex species distributions by the environmental-distance geometric mean. *Environmental Management* **32**:614-623.

- Hirzel, A.H., B. Posse, P.-A. Oggier, Y.C. Glenz, and R. Arlettaz. 2004. Ecological requirements of a reintroduced species, with implications for release policy: the Bearded vulture recolonizing the Alps. *Journal of Applied Ecology* **41**:1103-1116.